

# Comparison of Minimally Invasive Mitral Valve Surgery vs Open Mitral Valve Replacement

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## Abstract

**Objective:** To establish the advantages of invasive mitral valve surgery over open heart mitral valve surgery in treating patients with mitral valve pathologies.

**Material and Methods:** A literature search was done on PubMed, google scholar, and Embase using search terms like open 'invasive mitral valve surgery', 'mitral clip', 'sternotomy', and 'annuloplasty.' The time limit was set to 5 years ago and the language set to English. After searching, a quick screening of the title and abstract was done for relevance. The selected papers were then used in this review.

**Results:** The minimally invasive mitral valve surgery was shown to have significantly greater survival rates across all post-surgical time frames as well as lower short-term mortality rates. Mini MVS was also shown to be more effective in treating infective endocarditis and is a highly impractical operation for patients with left ventricular dysfunction or other cardiomyopathies. The Minimally Invasive Mitral valve surgery (Mini MVS) proved to cause fewer mortalities and clearly showed a lower number of complications; the complications that exist are highly preventable. In addition, the mini MVS is more effective in treating patients with mitral regurgitation.

**Conclusion:** This review confirms that employing the minimally invasive MVS procedure for patients with mitral valve pathologies is more effective than the standard open heart MVS in terms of post-surgery mortalities and hospital stay times. It is also more effective in treating patients with preexisting cardiomyopathies. However, sufficient training should be done to prevent complications from arising. The mitralclip device should be further developed to prevent complications that arise due to the clip attachment.

**Keywords:** Mitral Valve Surgery, Minimally Invasive Mitral Valve Surgery, Infective Endocarditis, Minimally Invasive Valve Repair

## Introduction

Surgical repair, whether it be surgical replacement or repair, as a standard of care in Mitral valve (MV) pathologies due to degenerative changes depends on many factors influenced by both patient as well as surgeon and center [1]. These include the pre-operative status of the patient, any comorbidities, and severity of disease, expertise and experience of the respective surgeons as well as the centers providing this treatment. Such a procedure takes place when analysis based on three principles; creating large surface of leaflet coaptation, remodeling the annulus to Left Ventricle provide stable and optimal orifice area and restoring or preserving full mobility of leaflets, comprehensively done [2]. Being one of the most common heart valves related surgeries, it is imperative to shed light on the current literature and look at what is known and what still needs lot needs to which is not known with as this a new technique its benefits will come and newer technique [3,4].

Previously conducted studies have reported on the short-term outcomes of the procedures that has observed that minimally invasive mitral valve surgery is favorable in terms of Intensive Care Unit (ICU) stay, need for blood transfusion and in hospital stay. Such findings are suggestive of the fact that minimally invasive approaches have become the choice of treatment with such benefits are reported some of the risk factors such as increased risk of stroke, aortic dissection or injury, cardiopulmonary bypass etc [5-7]. The limitation however in such studies is the length of time it was conducted thus calling for a review of long-term studies in order to assess the full potential of the said risks as well as benefits [7,8].

This review provides a comprehensive view of the current literature regarding the long-term survival rates of patient undergoing the surgery with any reported complications [7]. We shall also view the problems associated with the use the Mitra Clip and

help in the identification of any possible solutions proposed for it. Lastly a common factor while performing any surgery that is, the different comorbidities and its role in the outcomes will help in providing the readers good understanding of the potential high-risk patients who require additional care.

### Procedure Review

Tran’s catheter repair is a more invasive approach, occurs with the help of Mitral Clip, and used to treat symptomatic mitral regurgitation in those patients who cannot undergo open mitral valve surgery. The Mitral Clip is made up of metal alloys and a polyester fabric [9]. In this procedure, cardiopulmonary bypass is not required. First patients are placed under general anesthesia due to the need of a Tran’s esophageal echo. The access is taken via the femoral vein. First, a transept puncture is made so that the catheter can pass through. After this, a steerable guide sheath is inserted into the left atrium. The Mitral Clip delivery system goes through this sheath and to the mitral valve. The clip is positioned where the mitral regurgitation is greatest, and the clip arms attach to the leaflets and closes, preventing the leaflets from going backward, thus prevents regurgitation. The delivery system is removed, and femoral site closed [10].

Annuloplasty is a low-risk surgical procedure to repair mitral valve. First, an incision is created on the left atrium to reveal the mitral valve. Certain structures need to be identified, namely the anterior and posterior commissures, and the right and left trigon. In addition, the central portion of the leaflets must be identified, and this is done by viewing the portion supported by the chordae. Then, the first suture should be placed at the posterior commissure and right trigon. Another suture is placed at the left trigone. To avoid rhythm disturbances, the sutures should be placed at the atrio-valvular junction, 1 millimeter from the leaflet hinge with the needle towards the ventricular cavity. The third suture on the posterior annulus is placed the same way with the 2 stitches at a space of 2 millimeters from the leaflet hinge, penetrating the atriovalvular junction. The remaining sutures are to be placed with the same method at the posterior annulus. Using the inter-commissural distance and sept-lateral dimension to assess the size of the annulus, a prosthetic ring is selected. The annular sutures are passed within the ring, the ring is parachuted

into place and sutures are sealed. To check if the repair was successful, the ventricle is filled with cardioplegia, a process known as hydrodynamic valve testing [11].

Minimally invasive techniques are starting to be preferred over conventional surgery for many reasons as quoted by several research findings. With this procedure, the length of in hospital stay as well as intensive care unit stay was significantly reduced, and a more prominent finding was the reduced need for blood transfusion [5]. A study conducted showed that the in-hospital length of stay was significantly lower with those patients having undergone trans catheter procedure (11.56 days) as compared with those undergone open surgery (14.01 days) ( $p = <0.0001$ ) [12]. Furthermore, a 2013-14 registry involving those patients with mitral regurgitation (564 patients) showed that the Mitra Clip device had a 91.8% Success rate [13].

### Statistical Analysis

A comparison between the long-term survival rate in conventional mitral valve surgery and the new minimally invasive mitral valve surgery was done. Minimally invasive surgery showed to have better results in one, five, ten-year survival rates. The one, five, and ten-year survival rates were significantly higher in the minimally invasive cohort compared to the conventional approach (96%, 90%, and 84% vs. 89%, 85%, and 70%) [14]. Even when the short-term survival rate was compared, the minimally invasive technique showed better results. The mortality rate 30 days after discharge was far less in patients who underwent mini MVS as compared to the conventional MVS. Some data also suggests lower risk of perioperative morbidity and mortality with mini MVS.

We also wanted to compare the two procedures when done on patients with the same co morbid such as rheumatic mitral valve disease, infective endocarditis, left ventricular dysfunction (along with the mitral valve repair itself). Anh Tuan Vo, et al reports a study where people with rheumatic disease were treated with mini MVS refer to Table 1, thirty-day mortality was significantly lower (0.7%). The overall survival rate was also higher 98.6%. Freedom from reoperation was 97.1% [15].

**Table 1: Meta-Analysis of outcomes of Minimally Invasive Surgery**

Outcome	No. of patients	No. of studies	OR/WMD (95% CI)	p value	Heterogeneity, $\chi^2$	$\chi^2$ , p value
Mortality	1641	6	0.46 (0.15 to 1.42)	0.18	1.82	0.77
Stroke	1801	6	0.66 (0.23 to 1.93)	0.45	6.77	0.24
CPB	871	8	25.81 (13.13 to 38.50)	<0.0001	27.05	0.0003
XC	671	7	20.91 (8.79 to 33.04)	0.0007	24.98	0.0003
Re-op for bleeding	1553	5	0.56 (0.35 to 0.90)	0.02	0.63	0.96
New onset AF	539	4	0.86 (0.59 to 1.27)	0.45	2.25	0.52
ICU stay	309	4	-0.36 (-0.80 to 0.08)	0.1	3.26	0.35
Hospital stay	350	5	-0.73 (-1.52 to 0.05)	0.07	1.75	0.78

AF, atrial fibrillation; CPB, cardiopulmonary bypass time; ICU, intensive care unit; XC, cross-clamp time.

Cristina Barbero, et al report a mini MVS conducted on patients with infective endocarditis. Mini MVS showed and proved to be feasible for patients with I.E and was associated with better early and long-term results. Overall, actuarial survival rate at 1 and 5 years was 83%; freedom from MV reoperation and/ or recurrence of IE at 1 and 5 years was 97%. Thirty-day mortality was 11.4% [16]. The utilization of mini MVS approach has been rather controversial in presence of left ventricular (LV) dysfunction. A study was done comparing patients with LV dysfunction underwent minimally invasive MVS. Patients with LV dysfunction underwent mini MVS had low mortality (2.1% v 1.7%) and morbidity that was comparable with patients with normal ventricular function. Postoperative recovery was only slightly longer compared with patients with normal LV function as noted by

time to extubation (6.0 vs 7.0 hours) and hospital length of stay (7.0 vs 6.0 days) [17]. These shows that mini MVS is not only safe but also feasible for patients having a known cardiomyopathy with having minimal morbidity and mortality.

### Team Dynamics and Leadership

A successful team should consist of high-performing individuals who each understand their roles and work as a cohesive unit. Achieving this goal within a MIVS program requires substantial collaborative effort for success. The team of dedicated professionals includes a lead cardiac surgeon, a surgical assistant, cardiologists, per fusionists, anesthesiologists, operating room (OR) technicians, and nurses [18].

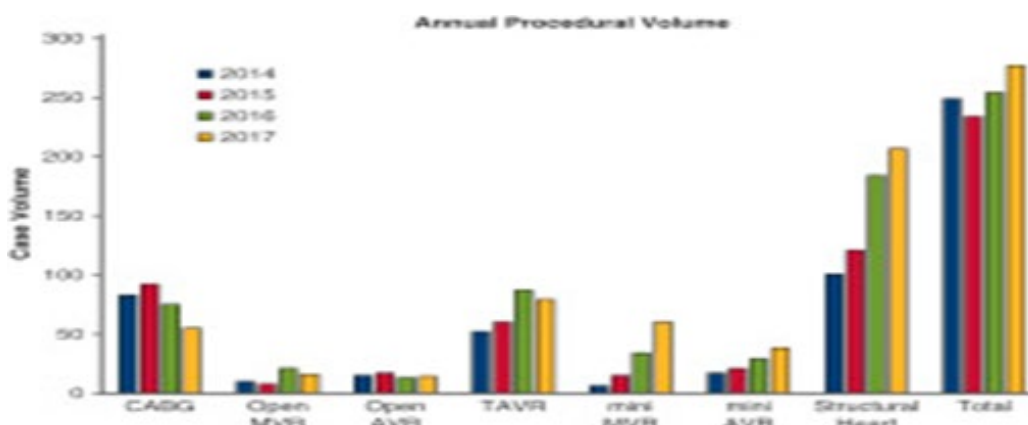


Figure 1: Development of mini MVS Program

### Complications

If we compare the clinical outcomes of the two procedures, that minimally invasive mitral valve repair is the ideal approach given the reduced the number of mortalities (952 mortalities for minimally invasive and 1011 for sternotomy) a lower number of adverse clinical outcomes (wound infection, cerebrovascular incidents etc) in the case of minimally invasive repair, as compared to sternotomy is MIVR is more effective. Lesser the cross-clamp time, time for cardiopulmonary bypass, and duration of hospitalization were all lower in the case of minimally invasive repair (although the ICU duration remained the same in 247 case of both procedures). This data further provide strength the fact that MIVR is a far safer procedure than the conventional sternotomy.

However, there are potential risks of irritation of the femoral nerve, seromas and lymphatic fistulas (while using the seldinger technique in which arterial air venous cannula are placed hi femoral vesse4) which can be prevented by properly clipping large vessels. In some cases, the femoral artery may be damaged after the cannula is removed. In addition, the risk of piercing the right atrial wall exists if canalization of the superior vena cava s carried out without Tran esophageal echo [19]. A times the surgeon is forced to convert to a full sternotomy if the pulmonary artery is damaged when placing the aortic cross lamp. Before the surgery proceeds further, the proper cannula positioning is ensured to minimize risk of the venous cannula being dislodged out of the superior vena cava outcomes of mini MVS vs CABG Table 2.

Table 2: Comparison of Mini invasive MVS VS MVR

OUTCOMES	Mini MVS	CABG
Bleeding	less	high
Transfusion of blood	less	high
Atrial fibrillation	less	high
Sternal wound infection	less	high
Sternal scar	less	high
Hospital Stay	8 days	15
Re valvular reintervention in Ist year	less	more
Stroke	high	less
Groin complication	high	less
Aortic dissection	high	less
Cross clamp and procedure time	long	short

## Life Threatening Complications

Phrenic nerve injury, vascular complications of the femoral artery aortic dissections, unilateral pulmonary edema, and perioperative strokes [10]. Partial clip detachment, embolization of clip, mitral valve stenosis, and clip entanglement in the chorda and mitral regurgitation are other potential complications of the mitral clip device [8]. Two studies have been carried out EVEREST 1 & EVEREST 2 to determine the potential complications of the Mitraclip [20-22]. The goal of EVEREST 1 was to evaluate the feasibility safety and efficacy of the Mitraclip system whereas the goal of EVEREST 2 was to evaluate the Mitraclip in those patients with elevated surgical risk due to previous cardiac surgery or multiple comorbidities. The results of EVEREST 1 concluded that the mitraclip system has reduced the rates of mortality and morbidity [22]. The results of EVEREST 2 concluded that the mitraclip system proved to be effective in patients suffering from mitral regurgitation and reduced other symptoms.

## Abbreviations

**MVS:** Mitral Valve Surgery

**MV:** Mitral Valve

**ICU:** Intensive Care Unit

**Mini MVS:** Minimally Invasive Mitral Valve Surgery

**IE:** Infective Endocarditis

**LV:** Left Ventricle

**MIVR:** Invasive Valve Repair

## Conclusion

Minimally invasive procedures are becoming increasingly common in today's age, considering the benefits especially in terms of postoperative care. Previously stated data showed that 30-day mortality rate, long-term survival and in hospital stay were all reduced in patients who underwent minimally invasive procedures. Furthermore, patients who were treated for rheumatic heart disease and infective endocarditis showed to have promising results with the minimally invasive techniques. To prevent complications involving the femoral vessels, adequate training must be given to those who will be required to perform, invasive procedures in their practice. In addition, more research and explanation is needed for the mini MVS and training to avoid complication so more center should use this technique. Population will be benefited. Because refusal to open heart surgery was high in our population and cost effective than mitral valve replacement so it is the need of time and large randomized trials needed in Pakistani population where rheumatic heart disease of mitral valve is more prevalent.

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